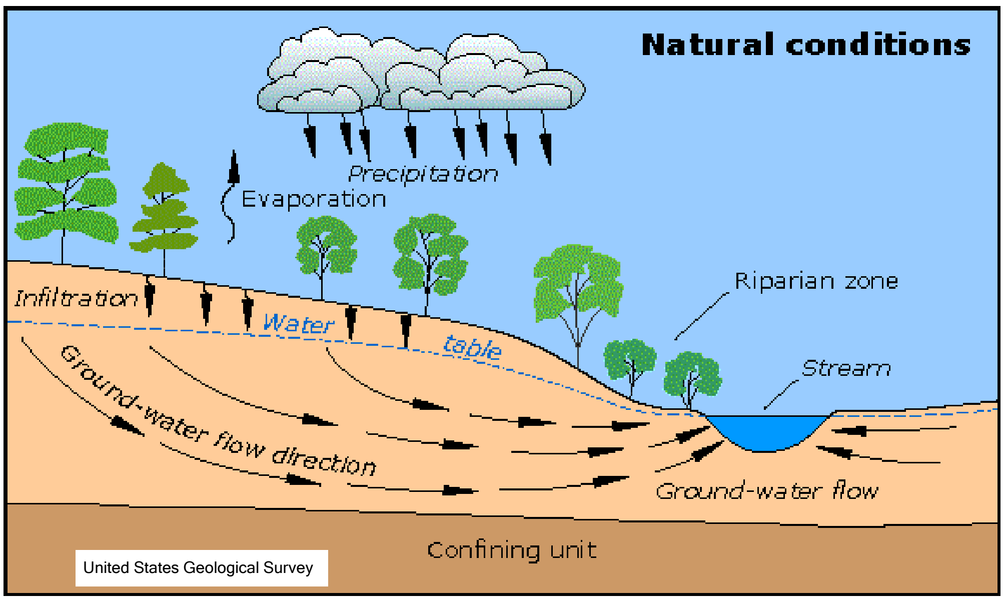
Ground Water

Water below the ground is called *ground water*. When many people think of ground water they picture it as "underground rivers". This is a myth. Ground water is actually found in the spaces (pore spaces) between gravel, sand and clay particles. In bedrock, the only place ground water can be found is in cracks and fissures. Ground water is precious. If it becomes contaminated—we can't use it. If it is overexploited, we lose the opportunity to achieve sustainability by balancing use and natural replenishment. Knowing where it comes from is an important first step.

Where Does Ground Water Come From?

Ground water is one part of the water cycle (also called the hydrologic cycle or hydrologic system). The water cycle consists of a series of transfers of water between the atmosphere, soils, plants, and surface waters. The diagram below shows the water cycle. Notice that water reaches the ground from the atmosphere as rain or snow, when it reaches the ground, it may runoff into streams or enter the ground water system by *infiltration*. Water may leave the ground and water surface and move back to the atmosphere by *evaporation*. The principal source of ground water *recharge* from infiltration is from snowmelt and rainfall. Some ground water may be recharged by leakage through rivers, wetlands and lakes. In the Gallatin Valley, irrigation plays an important role in ground water recharge; through irrigation ditches and flood irrigation.



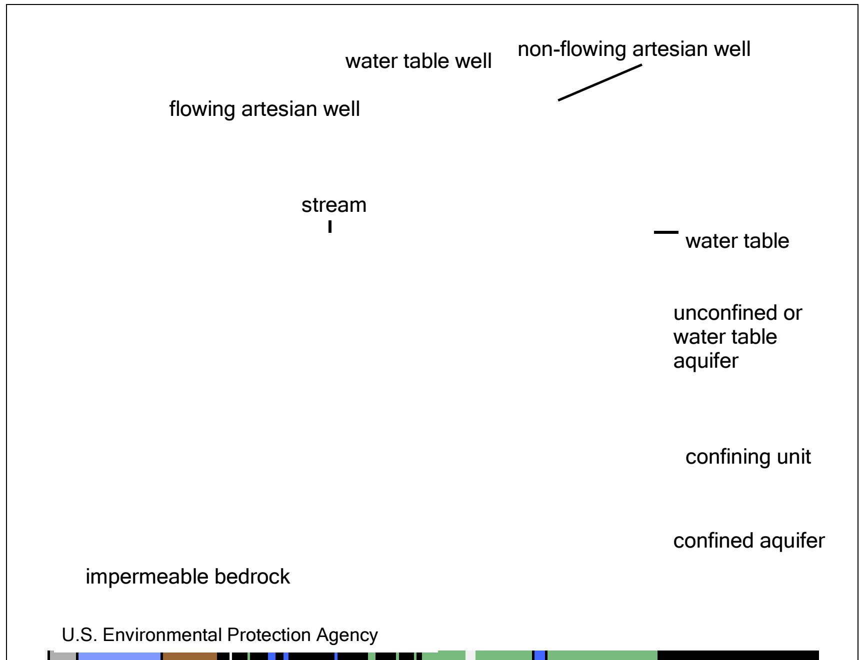
Ground water is always moving—but at a much slower rate than the water in streams and rivers—and eventually reaches wetlands, rivers and lakes. In fact, the base flow of our streams and rivers comes from ground water. There are two factors that affect the rate of ground water movement. The first is *hydraulic conductivity* (permeability and porosity) which reflects the ease with which the water moves in the pores. The pores must be connected so the ground water can move in them. The smaller or more poorly connected the pores, the more slowly the water moves through them. The second factor affecting the rate of ground water movement is the ground water *gradient* which reflects the energy available to move the ground water toward the rivers and lakes. This gradient is conceptually similar to the slope of the river but may be much smaller.

What is an Aquifer?

An aquifer is a geologic unit that produces ground water at an economically useful rate. What might be an aquifer for a home owner might not produce enough water for a subdivision or business. So, in some senses whether a geologic unit is an aquifer depends on who is discussing ground water. In other words, an aquifer is an underground geologic formation that contains ground water in sufficient quantities to be used, or has the potential to be used, for drinking water supply, commercial, industrial or agricultural purposes.

The soil, sediments or bedrock above an aquifer, where the pore spaces are not completely filled with water, is called the *unsaturated zone*. The boundary between the unsaturated zone and the ground water is called the *water table.* The vertical distance between the unsaturated zone and the water table varies from location to location. In some places it may only be a few feet to the water table—in others several hundred feet. Generally, the depth to the water table in mountainous areas is much deeper than beneath valleys. There is a difference between the water table and the *water level* in a well which may reflect the pressure in the ground water system. Thus the water level in a well is not always the water table. Water table boundary fluctuates with the amount of recharge from precipitation and snow melt, seasonal changes, drought, or excessive pumping of ground water. The response of the water table to these changes may take months or years depending on how far beneath the surface the aquifer is. Basically, there are two types of aquifers:

<u>Unconfined Aquifers</u>. Sometimes called water table aquifers, these are directly connected to the atmosphere and water on the ground above. There are no geologic materials that isolate the aquifer from the atmosphere, and while the water flows in the aquifer, flow is not required to connect the aquifer with precipitation, irrigation water or water from a stream or lake and the water table can rise and fall. Therefore, the saturated thickness of an unconfined aquifer can change with time. Because unconfined aquifers are not isolated, they can be vulnerable to contamination from activities on the land surface.



<u>Confined Aquifers</u>. These are covered by layers of impermeable or semi-permeable materials (confining unit), such as clay, which impede the movement of water into the aquifer from above except in the recharge area where the confining unit is absent. Confined aquifers are not directly recharged by vertical infiltration of water. They must be connected to an unconfined area for recharge to occur. Confining layers not only serve to hamper the movement of water into and out of the aquifer, they also serve as a barrier to the flow of contaminants from overlying unconfined aquifers. However, contaminants that reach a confined aquifer can be extremely difficult and expensive to remove.

Confined aquifers are sometimes described as *artesia*
level above the top of the aquifer. A well is flowing art … nd
surface.

In both unconfined and confined aquifers there may b
impermeable/semi-permeable sediments (such as cla
contact with permeable layers that are intersected by
may be a key part of the water storage in an aquifer sy

While aquifers can be thought of simply as unconfined or confined for educational purposes, in nature, most ground water occurs in far more complex *hydrogeologic systems* that can radically impact the movement of ground water. These systems might contain multiple overlying confined and unconfined aquifers, partially permeable or laterally incomplete confining beds, intersecting lakes and streams, intrusions of rock, faults, etc. Understanding these complexities is critical to designing adequate drinking water supplies.

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Adapted from:
"What is a Ground Water Aquifer?", U.S. EPA website, http://www.epa.gov/seahome/groundwater/src/geo3.htm.
"The ABC of Aquifers", "What is a Water Table?" & "Where Does Ground Water Come From?", American Ground Water Trust.
Pielou, E. C., <u>Fresh Water</u>, p. 5-30, University of Chicago Press. 1998.
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